

CLAIMS

1. A method for configuring a communication network
5 including a plurality (N) of antennas (14),
characterised in that it comprises the steps of:
- a) including in said plurality of antennas (14)
at least one (n) reconfigurable antenna adapted to
serve communication traffic in a respective coverage
10 area (S, P), said reconfigurable antenna having a
radiation diagram exhibiting a plurality of selectively
adjustable gain values for a set of directions ($\Delta\theta_i$,
 $\Delta\phi_j$), each direction in said set defining a
propagation path between the antenna (14) and a portion
15 (S, P) of said coverage area,
 - b) determining, for each direction ($\Delta\theta_i$, $\Delta\phi_j$) in
said set, at least one value of communication traffic
(T_{pixel}) and at least one attenuation value (a_{pixel}) over
said propagation path, and
 - 20 - c) selectively and independently allotting to
each direction in said set ($\Delta\theta_i$, $\Delta\phi_j$) a respective gain
value in the radiation diagram of said reconfigurable
antenna as a function of said at least one of said
traffic value (T_{pixel}) and of said attenuation value
25 (a_{pixel}) determined for said direction.
2. The method of claim 1, characterised in that
said gain value for each said direction is allotted as
the gain maximising a ratio (R_{bcpixel}) of said traffic
value to said attenuation value.
- 30 3. The method of claim 1, characterised in that
said gain value for each said direction is allotted as
the gain optimising a cost function ($f(a_0)$) wherein
said traffic value and said attenuation value represent
benefit and cost factors, respectively.

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4. The method of claim 1, characterised in that it includes the steps of:

- subdividing said coverage area of said at least one reconfigurable antenna in a plurality of portions (S) each including a plurality of pixels (P), wherein each said pixel has an associated value of communication traffic (T_{pixel}) and a propagation path from said antenna (14) with an associated attenuation value (a_{pixel}), whereby each said pixel has an associated benefit/cost ratio (R_{bc}) being the ratio of said associated communication traffic value (T_{pixel}) to said associated attenuation value (a_{pixel}),
- defining an optimisation function for all the pixels (P) within a given portion (S) depending on said benefit/cost ratio for the pixels (P) in said portion (S),
- allotting to the direction in said radiation diagram identifying each said portion (S) a respective gain value optimising said optimisation function.

5. The method of claim 4, characterised in that, each said pixel having associated a given value of attenuation and a_{min} being the minimum value of the values of attenuation for all the pixels in said given portion (S), said optimisation function is defined as

$$f(a_0) = (1/a_0) \sum T_{\text{pixel}}/a_{\text{pixel}}$$

where the summation extends for a_{pixel} from a_{min} to a_0 over all the pixels (P) in a given portion (S) of said coverage area, and $T_{\text{pixel}}/a_{\text{pixel}}$ is said benefit/cost ratio.

6. The method of claim 1, characterised in that it includes the steps of:

- selecting said at least one reconfigurable antenna (14) as an antenna having a maximum gain value (G_{max}),

- determining for each direction in said set a respective attenuation value (a_{mi}) to be compensated by a respective gain value in said radiation diagram, said attenuation values having a maximum (A_{max}), and
- 5 - associating to said direction in said radiation diagram gain values based on the relationship:
 - $G_{mi} = G_{max} - (A_{max} - a_{mi})$, wherein G_{max} is said maximum gain, A_{max} is said maximum of attenuation and a_{mi} is the attenuation value determined for the direction to which
- 10 the gain G_{mi} is assigned.
- 7. The method of claim 1, characterised in that it includes the steps of:
 - determining a field intensity value (E_{min}) required to provide said communication traffic over the
 - 15 area covered by the radiation diagram of said at least one reconfigurable antenna (14),
 - determining a power value (P_{feed}) for said antenna (14) to provide said field value (E_{min}),
 - comparing said power value determined (P_{feed}) with
 - 20 a maximum threshold value, and
 - if said power value as determined (P_{feed}) exceeds said maximum threshold value, issuing a signal indicating that the antenna (14) is to be relocated.
- 8. The method of claim 1, characterised in that it
- 25 includes the steps of:
 - configuring said network as a step of planning a still undeployed network, and
 - determining said respective value of communication traffic (T_{pixel}) as a planned parameter of
 - 30 said still undeployed network.
- 9. The method of claim 1, characterised in that it includes the steps of:
 - configuring said network as a step of managing an already existing network, and

- determining said respective value of communication traffic (T_{pixel}) as at least one of a forecast parameter and a measured parameter of said already existing network.

5 10. A method for configuring a communication network including a plurality (N) of antennas (14) each serving a respective amount of traffic within a respective coverage area, characterised in that it comprises the steps of:

10 - determining a reference amount of traffic (T_m) served by said plurality (N) of antennas in the network,

- setting at least one difference threshold with respect to said reference amount of traffic (T_m),

15 - identifying among said plurality of antennas (N) a subset (n) of antennas, wherein the respective amounts of traffic served by the antennas in said subset reach said difference threshold, and

20 - configuring the antennas (n) in said subset as reconfigurable antennas, each having a radiation diagram exhibiting a plurality of selectively adjustable gain values for a set of directions ($\Delta\theta$, $\Delta\phi$), each direction in said set defining a propagation path between the antenna (14) and a portion (S, P) of said coverage area, and

25 - applying to the reconfigurable antennas in said subset the steps b) and c) of claim 1 to reconfigure said network.

30 11. The method of claim 10, characterised in that it comprises the step of defining said reference amount of traffic as the average amount of traffic (T_m) served by said plurality of antennas.

35 12. The method of claim 10, characterised in that it comprises the step of checking (106; 208) the performance level of said reconfigured network.

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13. The method of claim 12, characterised in that it comprises the steps of:

- defining at least one criterion for satisfactory performance level of said network,

5 - checking (106; 208) the performance level of said reconfigured network against said criterion, and

- if said checking (106; 208) reveals that said performance level fails to meet said criterion, taking at least one of the steps of:

10 - varying (110; 212) said reference amount of traffic (T_m),

- increasing the number (n) of said reconfigurable antennas in said subset, and

15 - increasing (218) the total number (N) of antennas in the network.

14. A network architecture for a communication network including a plurality (N) of antennas (14), characterised in that it comprises:

20 - at least one (n) reconfigurable antenna adapted to serve communication traffic in a respective coverage area (S, P), wherein

25 - said at least one reconfigurable antenna has a radiation diagram exhibiting a plurality of selectively adjustable gain values for a set of directions ($\Delta\theta_i, \Delta\phi_j$), and wherein

- each direction ($\Delta\theta_i, \Delta\phi_j$) in said set

- defines a propagation path between the antenna (14) and a portion (S, P) of said coverage area, and

30 - has associated

- at least one value of communication traffic (T_{pixel}) and at least one attenuation value (a_{pixel}) over said propagation path; and

35 - a respective gain value for said radiation diagram which is a function of at

least one of said traffic value (T_{pixel}) and of said attenuation value (a_{pixel}).

15 15. The network architecture of claim 14, characterised in that said gain value for each said direction is the gain maximising a ratio (R_{bcpixel}) of said traffic value to said attenuation value.

10 16. The network architecture of claim 14, characterised in that said gain value for each said direction is the gain optimising a cost function ($f(a_0)$) wherein said traffic value and said attenuation value represent benefit and cost factors, respectively.

17. The network architecture of claim 14, characterised in that:

15 - said coverage area of said at least one reconfigurable antenna is subdivided in a plurality of portions (S) each including a plurality of pixels (P), wherein each said pixel has an associated value of communication traffic (T_{pixel}) and a propagation path from said antenna (14) with an associated attenuation value (a_{pixel}), whereby each said pixel has an associated benefit/cost ratio (R_{bc}) being the ratio of said associated communication traffic value (T_{pixel}) to said associated attenuation value (a_{pixel}),

25 - for all the pixels (P) within a given portion (S) an optimisation function exists depending on said benefit/cost ratio for the pixels (P) in said portion (S),

- said gain value for each said direction is the gain optimising said function.

30 18. The network architecture of claim 17, characterised in that, each said pixel having associated a given value of attenuation and a_{min} is the minimum value of the values of attenuation for all the pixels in said given portion (S), said optimisation
35 function is defined as

$$f(a_0) = (1/a_0) \sum T_{\text{pixel}}/a_{\text{pixel}}$$

where the summation extends for a_{pixel} from a_{min} to a_0 over all the pixels (P) in a given portion (S) of said coverage area, wherein $T_{\text{pixel}}/a_{\text{pixel}}$ is said benefit/cost ratio.

19. The network architecture of claim 14, characterised in that:

- said at least one reconfigurable antenna (14) is an antenna having a maximum gain value (G_{max}), and wherein for each direction in said set a respective attenuation value (a_{mi}) exists to be compensated by a respective gain value in said radiation diagram, said attenuation values having a maximum (A_{max}), and

- each said direction in said radiation diagram has an associated gain value G_{mi} based on the relationship:

- $G_{\text{mi}} = G_{\text{max}} - (A_{\text{max}} - a_{\text{mi}})$, wherein G_{max} is said maximum gain value, A_{max} is said maximum attenuation and a_{mi} is an attenuation value determined for the direction to which the gain value G_{mi} is assigned.

20. A computer program product loadable in the memory of at least one computer and including software code portions for performing the method of claims 1 to 13.